Kosmas Kepesidis
(Munich)

The Bose-Hubbard model with particle losses at one lattice site.

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In this work, we consider the one-dimensional Bose-Hubbard model with particle losses at one lattice site. Ultra-cold bosonic atoms in a one-dimensional optical lattice can provide a possible realization. Focusing an electron beam on a single site can generate the one-site particle losses. The atoms will be ionized when scattered by the electrons of the beam and the ions can be driven off the lattice by a uniform electric field. For the description of this system, we derive an effective Born-Markov master equation treating the dissipative lattice site as a quantum environment. We first investigate the case where the system is a perfect superfluid. We find that when the dissipative site is located exactly in the middle of the lattice, half of the bosons of an initially homogeneous particle distribution, are not affected by the dissipation. A physical interpretation of this result is that the surviving particles interfere destructively when they tunnel to the location of the defect and therefore never reach the lossy site. When we include interactions, the phase coherence is destroyed and all particles will eventually decay. However, this process could be slowed down by appropriate tuning of the parameters. Finally, we consider the case where the lossy site is not at the center of the chain and we investigate whether there is a slow-down of particle losses, for some range of the parameters.